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Answer ALL the questions. Write your answers in the spaces provided.

1. Chlorine is manufactured by the electrolysis of concentrated brine in a **membrane** cell.

(a) State the material from which the anode is made.

.....
(1)

(b) Write the half-equation for the reaction at the anode.

.....
(1)

(c) **Explain** whether the reaction at the anode is an oxidation or a reduction process.

.....
.....
(1)

(d) Which ions are able to pass through the membrane in this cell?

.....
(1)

(e) Identify the product at the cathode.

.....
(1)

(f) Write the overall equation for the decomposition of brine by electrolysis.

.....
(2)

(g) State ONE large-scale use of chlorine.

.....
(1)

(Total 8 marks)

Q1



2. (a) Chlorofluorocarbons, CFCs, are useful compounds as they are non-flammable and unreactive. In the stratosphere, the C—Cl bonds are broken producing free radicals.

(i) Draw the structure of 1,1,2-trichloro-1,2,2-trifluoroethane.

(1)

(ii) Suggest why C—F bonds are **not** broken in the stratosphere, whereas C—Cl bonds are.

.....
(1)

(iii) What are free radicals and what is needed to produce them from CFCs?

.....
.....
(2)

(b) (i) Draw the repeating units in

poly(chloroethene)

poly(tetrafluoroethene).

(2)

(ii) Give ONE important use of each of these polymers.

poly(chloroethene)

poly(tetrafluoroethene)

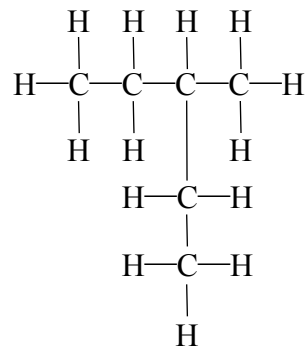
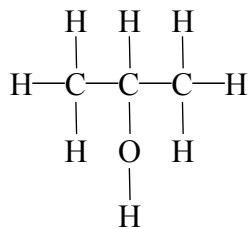
.....
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(2)

(Total 8 marks)

Q2



3. (a) Name each of the following organic compounds and the homologous series to which it belongs.



Name

Name

Homologous Series

Homologous Series

(4)

- (b) (i) Draw the TWO **structural** isomers of $\text{C}_2\text{H}_2\text{Cl}_2$.

(2)

- (ii) Identify which of the two structural isomers of $\text{C}_2\text{H}_2\text{Cl}_2$ can exist as geometric isomers. Explain why geometric isomerism can occur.

Identity

Explanation

.....

(2)

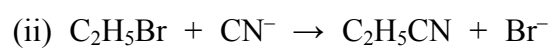


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(c) Classify the following organic reactions.



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(1)



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(1)

(d) A hydrocarbon has the empirical formula CH_2 and a relative molecular mass of 70.

Write the molecular formula of the hydrocarbon.

.....
(1)

(Total 11 marks)

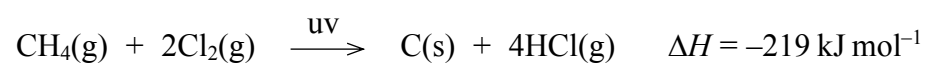
Q3

5

Turn over



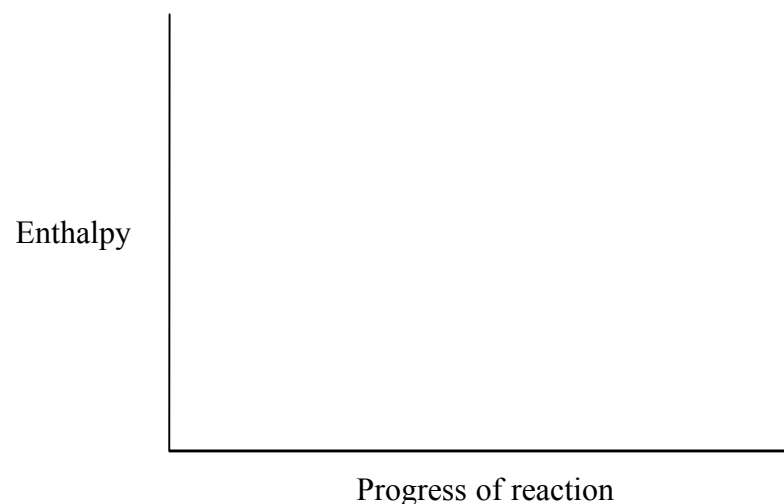
4. (a) When excess chlorine and methane are mixed at room temperature and pressure no reaction takes place but when ultraviolet light is shone into the mixture an explosion occurs, producing carbon and hydrogen chloride.



Calculate the mass of methane needed to produce 1000 kJ of energy.

(2)

- (b) Draw a **labelled** reaction profile for the reaction between methane and chlorine and use it to explain why the reaction does **not** take place unless ultraviolet light is present.



Explanation

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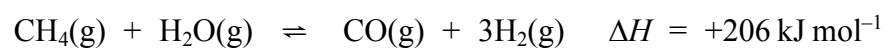
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(5)



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(c) Hydrogen gas is manufactured by passing methane and steam over a heated catalyst.



Explain the effect, if any, on the equilibrium yield of hydrogen by using:

(i) a higher pressure

.....
.....
.....
.....
.....

(2)

(ii) a higher temperature

.....
.....
.....
.....
.....

(2)

(iii) a catalyst.

.....

(1)

(Total 12 marks)

Q4

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5. (a) Define the term **standard enthalpy of combustion**.

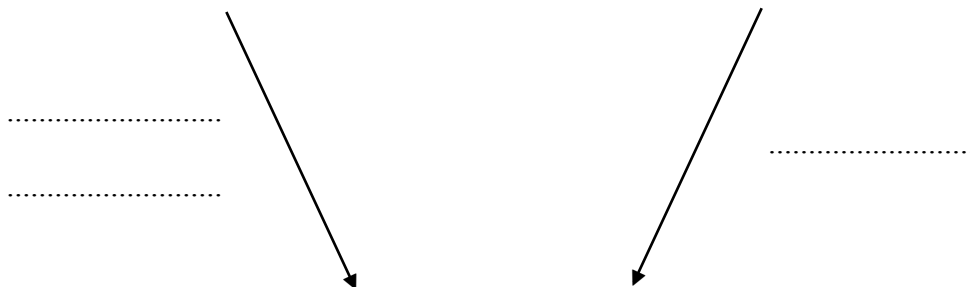
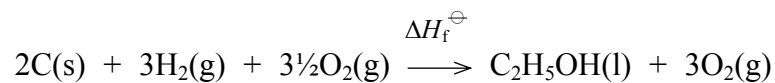
.....

(3)

(b) The following standard enthalpies of combustion are needed to calculate the standard enthalpy of formation of ethanol, C₂H₅OH.

Substance	Standard enthalpy of combustion /kJ mol ⁻¹
carbon, C (s, graphite)	-394
hydrogen, H ₂ (g)	-286
ethanol, C ₂ H ₅ OH (l)	-1371

(i) Complete the Hess's Law cycle by filling in the box and labelling the arrows with the enthalpy changes.



..... +

(3)

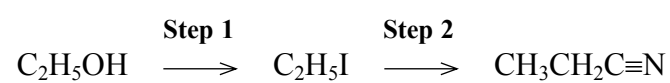


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(ii) Use your Hess's Law cycle to calculate the standard enthalpy of formation of ethanol.

(2)

(c) Ethanol, C_2H_5OH , can be converted into propanenitrile, $CH_3CH_2C\equiv N$ in two steps.



Give the reagents for the steps.

Step 1

Reagents

.....
.....

Step 2

Reagent

.....

(3)

Q5

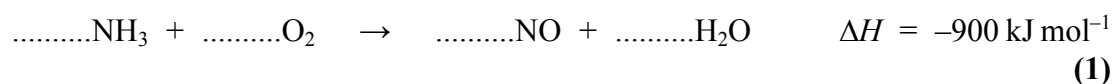
(Total 11 marks)



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6. The first step in the manufacture of nitric acid is the catalytic oxidation of ammonia. The reaction is usually carried out at 900 °C.

(a) (i) Balance this equation.



(ii) Identify the catalyst used in this reaction.

.....

(1)

(iii) State and explain the effect on the rate of reaction of using a temperature lower than 900 °C.

.....

.....

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.....

.....

.....

(3)

(b) Outline the steps which convert nitrogen monoxide, NO, from the oxidation of ammonia, into nitric acid. Identify the intermediate compound.

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(4)

(c) Give ONE important use of nitric acid.

.....

(1)

Q6

(Total 10 marks)

TOTAL FOR PAPER: 60 MARKS

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N 2 6 0 2 2 A 0 1 1 1 2

THE PERIODIC TABLE

Period **1** **2** **3** **4** **5** **6** **7** **0**

Period

1	H Hydrogen 1
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Key	
Molar mass g mol ⁻¹	Symbol
Symbol	Name
Name	Atomic number

4	He Helium 2
----------	--------------------------

7	Li Lithium 3	Be Beryllium 4	B Boron 5	C Carbon 6	N Nitrogen 7	O Oxygen 8	F Fluorine 9	Ne Neon 10
2	Li Lithium 3	Be Beryllium 4	B Boron 5	C Carbon 6	N Nitrogen 7	O Oxygen 8	F Fluorine 9	Ne Neon 10
3	Na Sodium 11	Mg Magnesium 12	Al Aluminium 13	Si Silicon 14	P Phosphorus 15	S Sulphur 16	Cl Chlorine 17	Ar Argon 18
4	K Potassium 19	Ca Calcium 20	Sc Scandium 21	Ti Titanium 22	V Vanadium 23	Cr Chromium 24	Mn Manganese 25	Fe Iron 26
5	Rb Rubidium 37	Sr Strontium 38	Y Yttrium 39	Zr Zirconium 40	Nb Niobium 41	Mo Molybdenum 42	Tc Technetium 43	Ru Ruthenium 44
6	Cs Caesium 55	Ba Barium 56	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76
7	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82

11	B Boron 5	Al Aluminium 13	Si Silicon 14	P Phosphorus 15	S Sulphur 16	Cl Chlorine 17	Ar Argon 18
12	C Carbon 6	Si Silicon 14	Ge Germanium 32	As Arsenic 33	Se Selenium 34	Br Bromine 35	Kr Krypton 36
13	B Boron 5	Al Aluminium 13	Ga Gallium 31	In Indium 49	Tl Thallium 81	Pb Lead 82	Rn Radon 86
14	N Nitrogen 7	P Phosphorus 15	As Arsenic 33	Sb Antimony 51	Bi Bismuth 83	Po Polonium 84	At Astatine 85
15	O Oxygen 8	S Sulphur 16	Se Selenium 34	Te Tellurium 52	Po Polonium 84	At Astatine 85	Rn Radon 86
16	F Fluorine 9	Cl Chlorine 17	Br Bromine 35	I Iodine 53	At Astatine 85	Rn Radon 86	Rn Radon 86
17	Ne Neon 10	Ar Argon 18	Kr Krypton 36	Xe Xenon 54	Rn Radon 86	Rn Radon 86	Rn Radon 86
18	Ne Neon 10	Ar Argon 18	Kr Krypton 36	Xe Xenon 54	Rn Radon 86	Rn Radon 86	Rn Radon 86

140	Ce Cerium 58	Pr Praseodymium 59	Nd Neodymium 60	Pm Promethium 61	Sm Samarium 62	Eu Europium 63	Gd Gadolinium 64	Tb Terbium 65	Dy Dysprosium 66	Ho Holmium 67	Er Erbium 68	Tm Thulium 69	Yb Ytterbium 70	Lu Lutetium 71
141	Pr Praseodymium 59	Nd Neodymium 60	Pm Promethium 61	Sm Samarium 62	Eu Europium 63	Gd Gadolinium 64	Tb Terbium 65	Dy Dysprosium 66	Ho Holmium 67	Er Erbium 68	Tm Thulium 69	Yb Ytterbium 70	Lu Lutetium 71	Lu Lutetium 71
142	Pr Praseodymium 59	Nd Neodymium 60	Pm Promethium 61	Sm Samarium 62	Eu Europium 63	Gd Gadolinium 64	Tb Terbium 65	Dy Dysprosium 66	Ho Holmium 67	Er Erbium 68	Tm Thulium 69	Yb Ytterbium 70	Lu Lutetium 71	Lu Lutetium 71

232	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103
233	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103
234	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

